1997

FEDERAL HIGHWAY ADMINISTRATION

research and technology *program highlights*

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contents

This report highlights the activities and accomplishments of the Research and Technology (R&T) Program of the Federal Highway Administration (FHWA) during fiscal year (FY) 1997—October 1, 1996, through September 30, 1997. The first R&T Highlights report was published for FY 1993; this report for FY 1997 is the fifth such report. The information for this report was gathered through interviews with key FHWA officials and staff. The report describes the major R&T projects and programs and the progress made in FY 1997 by the following Research & Technology Coordinating Groups: intelligent transportation systems; pavements; structures; highway operations; safety; motor carriers; international programs; planning, environment, and right-of-way; and policy and information management. Each project is listed according to the FHWA strategic goal that it best advances. The report also briefly describes the management structure of the R&T Program.

To access this report on the Internet, please visit the resource center of the Turner-Fairbank Highway Research Center web site at http://www.tfhrc.gov. While supplies last, printed copies of this report are also available, without charge, from:

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Communication Services, HRD-10
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statement of the administrator

A primary responsibility of the Federal Highway Administration (FHWA) for more than 100 years—from the very beginning of its original predecessor, the Office of Road Inquiry, in 1893—has been to conduct research and to share information (now often called technology transfer) about how to build better roads. This long-time responsibility is taking on a new emphasis as literally thousands of new technologies are emerging and as the highway mission has taken on a stronger role in operations and intermodal linkages.

Kenneth R. Wykle,
Administrator,
Federal Highway Administration

As stated in the White House report *Technology in the National Interest*, "Our ability to harness the power and promise of leading-edge advances in technology will determine, in large measure, our national prosperity, security, and global influence, and with them the standard of living and quality of life of our people." Certainly, that statement is just as applicable to transportation as it is to any other area of American life.

"The U.S. Department of Transportation's program of transportation research, development, and technology application is a central element of the Administration's strategy for advancing American competitiveness abroad and improving our quality of life at home," said Secretary of Transportation Rodney E. Slater. The Secretary went on to say that a broad and multimodal research effort is crucial to the achievement of his vision for the Department to lead the way to transportation excellence in the 21st century.

FHWA, through our Research and Technology (R&T) Program and in partnership with other Federal agencies, State and local governments, academia, the private sector, and the American people, is leading the way to the future, creating the safest and most effective surface transportation system in the world. We are working to create a surface transportation system that provides everyone with access within and beyond their community and to the world; a system that practically eliminates crashes, delays, and congestion; a system that facilitates the timely movement of freight at the lowest cost; a system that protects ecosystems and does not degrade air quality; and a system that is able to quickly restore essential services after disasters and emergencies.

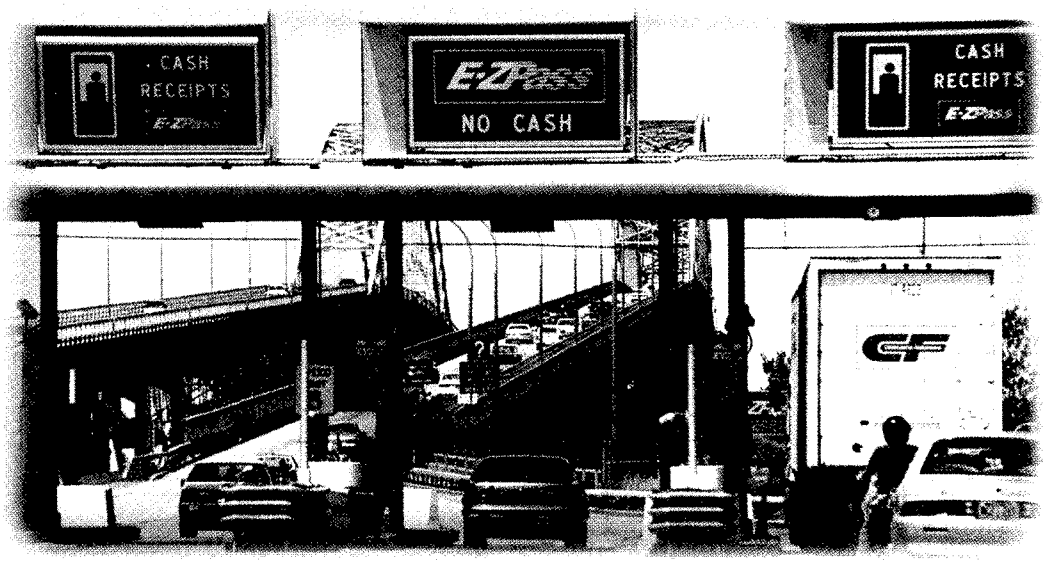
The system of the 21st century will be one that links all modes of transportation in a seamless, efficient fashion. It will be one that overlays information-age communications technologies on the physical infrastructure of the 20th century.

This report provides an overview of the highlights of our R&T Program during fiscal year 1997. This is not a comprehensive description of all of the important programs and projects of the agency. The purpose of this report is to present a general survey of FHWA's R&T activities and accomplishments to enable you to acquire a perspective of the massive contributions that FHWA, in conjunction with our many partners, is making to improve the prosperity and quality of life for all Americans.

Kenneth R. Wykle

introduction

The mission of the Federal Highway Administration (FHWA) is to continually improve the Nation's highway system and its intermodal connections—to make travel and transit along the Nation's highways easier, more economical, safer, gentler on the environment, and more efficient. The Research & Technology (R&T) Program advances the goals of FHWA by providing innovative research, new technology, and the application of that technology in ways that will improve the quality of service offered by our highway system. Simply put, the R&T Program is designing the methods, materials, and tools that will enable FHWA to provide the American people with the world's best transportation system—one that is getting better all the time.



Automating highway systems to streamline the transportation network.

PHOTO COURTESY OF THE NEW YORK THRUWAY AUTHORITY

Innovation on Demand

The professionals who direct and carry out the work of the R&T Program are continually looking for new ways to solve old problems. Perhaps the quickest way to sum up the Program's philosophy is to quote Albert Einstein who said, "The significant problems we face cannot be solved by the same level of thinking that created them." This is the spirit of innovation that captures the curiosity and creative genius of members of the R&T Program.

In fiscal year (FY) 1997, the R&T Program has succeeded in areas that could hardly have been imagined a decade ago but were demonstrated or deployed this year. The Automated Highway System demonstration, high-performance steel, and ALERT (Advanced Law Enforcement and Response Technology) vehicle technology are a few examples. Some of our successes that have been critical to the creation of new ideas, methods, and materials have come about through increased partnerships with other government agencies, private enterprise, or academia. We have found that good ideas are not created in a vacuum, but through input from a myriad of sources that help move technological advances out of the laboratory and onto our highways.

Who Guides the R&T Program?

Under the direction of the Federal Highway Administrator and in accordance with FHWA's strategic plan and key priorities, the Research and Technology Executive Board (RTEB) provides policy direction for the R&T Program. The RTEB sets R&T Program priorities, allocates program funds, and reviews its progress in meeting goals. The RTEB is chaired by FHWA's Executive Director, Anthony Kane, and its members include FHWA's six Associate Administrators, two of the nine Regional Administrators, and the Director of the Joint Program Office for Intelligent Transportation Systems (ITS), as listed on the inside front cover of this publication.

Nine Research and Technology Coordinating Groups (RTCG's) operate under the direction of the RTEB. The RTCG's are the proactive leaders and the "champions" of innovation within their respective areas of expertise: safety; pavements; structures; highway operations; planning, environment, and right-of-way; policy and information management; motor carriers; intelligent transportation systems; and international programs. The RTCG's identify the transportation problems or issues that R&T development can help resolve; determine their role in resolving the problem or issue; formulate their portion of the R&T Program budget, including information on goals, products, and milestones; and report to the RTEB on their plans, products, and achievements. The chairpersons of the RTCG's are listed on the inside front cover.

The FHWA Research and Technology Coordinating Committee (RTCC) is a special committee convened by the Transportation Research Board (TRB) at our request. RTCC assists us in identifying gaps in research; in considering ways to increase State, local, and private sector participation in highway research; in addressing issues related to the implementation of research results; in identifying areas of duplication; and in providing a mechanism for gathering research needs. We also actively seek input to our program from expert groups such as the Intelligent Transportation Society of America and the National Motor Carrier Advisory Committee. These groups provide information on R&T activities in specific areas, monitor research progress, and recommend applications of research findings.

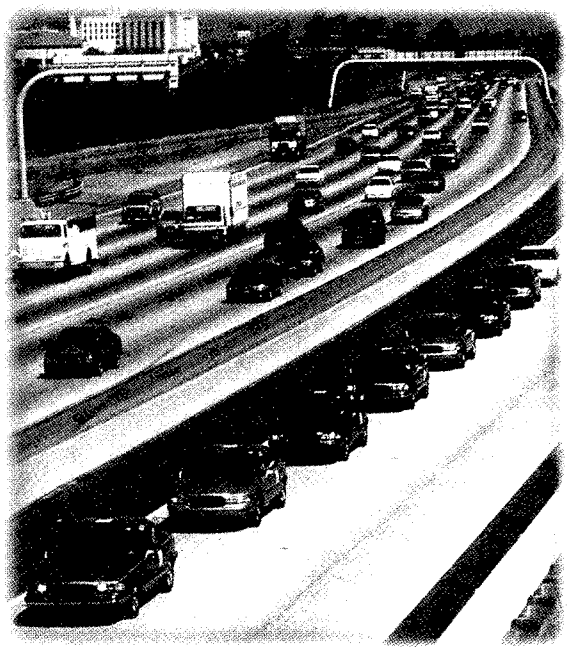
Organization of This Report

This publication provides a brief glimpse of some of the year's most compelling projects—those with the most potential to change the lives of the average motorist, passenger, or trucker who travels our Nation's highways—and a selection of the awards we received in FY 1997. To emphasize how our successes correspond to FHWA's mission, this year's highlights are listed in five sections that reflect FHWA's five strategic goals: (1) mobility, (2) productivity, (3) safety, (4) human and natural environment, and (5) national security. Although much of our work relates to several goals simultaneously, each project is listed under the goal it advances the most.

STRATEGIC GOAL 1:

mobility

FHWA's goal to improve the operational efficiency of the highway system, including its intermodal connections, provides an opportunity to use technology to make the system operate even better. New technologies applied to roadway applications enabled us to move from conceptualizing the Automated Highway System (AHS) of the future to successfully demonstrating it on a section of San Diego highway in August 1997. Through the Intelligent Vehicle Initiative, of which AHS is a building block, automated systems will allow us to double the throughput of existing lanes by placing platoons of vehicles, spaced more closely together than manual driving safely permits, on the roadway.



Platooning vehicles at the AHS Demonstration in San Diego, CA.

With the achievement of the AHS demonstration in hand, it is obvious that the technology to create smart cars and intelligent highways is here. But just as the Nation's Interstate Highway System was designed to provide the backbone of our Nation's surface transportation system, we now need to turn our attention to designing an intelligent transportation infrastructure that will integrate in-vehicle and roadway electronic systems, communications systems, and all of the hardware and software elements that have useful applications on our highways.

The challenge is in standardizing these individual systems so that they are capable of communicating with each other and then linking them together to create a seamless intermodal transportation system that operates across jurisdictions throughout the Nation. Creating a national architecture for the electronic layer of our transportation system is a new way of looking at applying technology. We feel that this is the logical approach to designing the Intelligent Transportation Systems (ITS) that will define the next generation of electronically enhanced highways.

While our efforts to use ITS hold promise for the future, there are many ways in which we are increasing mobility today. From urban areas where we are employing new methods for removing snow from congested city streets to desolate mountain locations where automated systems are minimizing avalanche hazards, we have applied new ways of thinking about old problems and have designed ground-breaking solutions. FHWA is also marketing new tools to assist transportation officials in making better decisions about the scope and extent of needed improvements. New materials and methods, as well as programs designed to foster the use of these new technologies, are reducing the need for costly road repairs that slow down traffic. New methods of contracting for road construction and maintenance are offering innovative rewards and disincentives that are designed to minimize disruptions in traffic flow. The concept is simple—keep it moving and make it move more efficiently now and in the future.

Taking an inventory of daily personal travel. Before we try to increase mobility, we have to know where people want to go and their preferred mode of transport for getting there. This is the purpose of the Nationwide Personal Transportation Survey (NPTS), a data-gathering and analysis task that has been performed periodically since 1969. In FY 1997 we made the latest NPTS data set available to the public for use to quantify travel behavior, analyze changes in travel trends over time, relate travel behavior to the traveler demographics, and understand the relationships between demographics and travel over time and between travel and land use.

Getting more vehicles where they're headed. There are two ways to increase road capacity and relieve traffic congestion. One is to continue to build more roads and enlarge those already in the highway system. Another is to use the roads in existence more efficiently so that they are capable of operating at their full capacity. For several days in August, the AHS technical feasibility field test, dubbed Demo '97, proved that we are capable of safely moving automated vehicles on existing highway facilities. On nearly 8 miles of Interstate 15 in San Diego, CA, specially outfitted vehicles operated in two clearly delineated lanes, moving at a constant speed under computer control. Not unlike train cars on a track, these vehicles move closely together in groups of 10 or 20, at a consistent speed. Each vehicle in the group is in constant communication with other vehicles in the group, relaying information on speed, position, and other data at a rate of 50 times per second. Increasing capacity on high-volume roads without building additional lane miles of infrastructure is a viable and economic solution to traffic problems in many of our large urban areas. To enhance existing highways with AHS technology is estimated to cost less than $10,000 per freeway mile, whereas it now costs from $1 million to $100 million to build one new mile of highway.

Guiding the development of ITS for the Nation. In FY 1997, we developed the main body of the National ITS Architecture, an

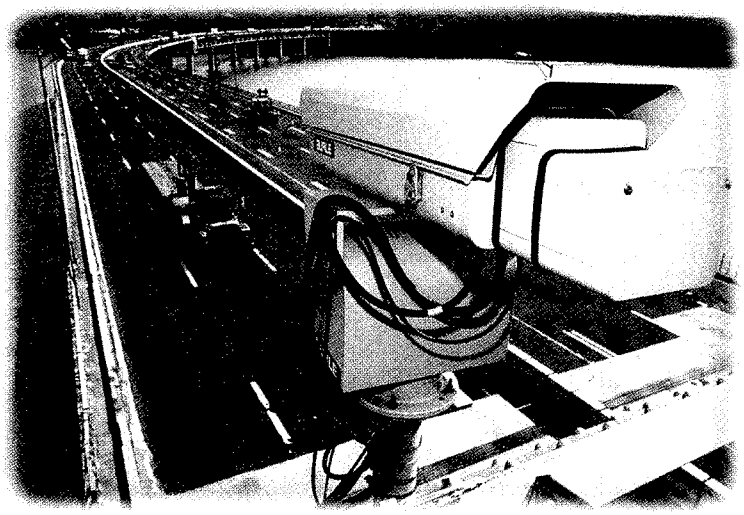


PHOTO COURTESY OF NEW YORK STATE THRUWAY AUTHORITY

Using ITS surveilance technologies for incident/emergency management and traveler information.

important initial step toward achieving the vision of a nationwide, fully integrated and intermodal ITS infrastructure. Phoenix, San Antonio, Seattle, and the New York City metropolitan areas were chosen to showcase deployments of intelligent transportation systems. The program, call Model Deployment Initiatives, calls for public and private sector partners to develop and integrate an intelligent transportation infrastructure (ITI) to reduce travel times, improve emergency response, and provide travel information to the public. Eight States implementing Commercial Vehicle Information Systems and Networks (CVISN) will also rely on the National ITS Architecture as a comprehensive guiding framework for integrating ITS.

We are also developing user-friendly deployment guidance documentation from the perspective of the local or regional transportation community. These guidance documents employ a big-picture approach to regional transportation through a regional ITS architecture. Guidance documents are currently being developed for systems involving freeway management, traffic signal control, incident/emergency management, and traveler information.

ITS for both urban and rural areas. Metropolitan ITS infrastructure is currently being tested and deployed in many locations around the country. But what is helpful in metropolitan areas often is not as useful in less populated settings, so rural ITS solutions are being designed to provide police, firefighters, and emergency medical personnel with pinpoint locations through the use of global positioning systems; give farmers site-specific weather forecasts; and move commercial vehicles safely and efficiently over lengthy stretches of rural interstate highways with the use of variable message signs, automated weigh-in-motion detection technology, automatic truck-rollover warning systems, and truck downhill speed warning systems.

Making tracks. The Real-Time Traffic Adaptive Signal Control System (RT-TRACS) Project is developing control algorithms for real-time control of surface street and freeway ramp signals under conditions of normally varying traffic, including crashes. Unlike traditional traffic control strategies that do not respond to abnormal traffic conditions, RT-TRACS uses a suite of control logic that is selected to best fit the traffic situation as it unfolds. This permits more responsiveness to changing traffic conditions.

Explaining ITS applications and expanding our capabilities. In June 1997, we inaugurated the Advanced Transportation Management Technologies Demonstration Project. This 3-year project focuses on representative ITS technologies that can be deployed in transportation infrastructures and have been loaned by partners from both private and public sectors. Demonstrations will display the role of each technology in controlling congestion and improving mobility and safety. These technologies are showcased in a high-profile mobile classroom that provides interactive hands-on demonstrations on a variety of hardware and software.

In a related effort, we have recognized that ITS deployment requires skills that go beyond a traditional civil engineering education, and therefore, through our ITS Professional Capacity Building Program, we will develop a cadre of trained professionals at the Federal, State, and local levels who will be capable of planning, designing, implementing, operating, and maintaining ITS technologies and strategies.

Seeing it before you build it. At the ITS America Annual Meeting in Washington, DC,

last May, Executive Director Kane introduced the most recent software package developed in our travel management research program. The Traffic Software Integration System, or TSIS, is a powerful, open-architecture approach to analyzing complex traffic operations problems. This enhanced capability, now available to transportation professionals, simplifies the use of existing models through a graphical input processor and powerful visualization package. The TSIS has already been used in a number of States to help identify superior design options when considering alternatives to reconfigure existing substandard interchanges. The ease of use, rapid processing, and side-by-side views of different solutions to specific problem interchanges make TSIS a valuable addition to every transportation official's "analysis tool box."

Keeping pavement repairs to a minimum. Pavements less prone to cracking require less maintenance and that translates into fewer lane closures and added mobility. What if we could prevent the causes of pavement cracking in new concrete pavements and bonded overlays of existing concrete pavements before construction even begins? That is the innovative thinking behind HIPERPAV, a Windows™-based computer program that enables a detailed graphical representation of the stress and strength that will develop in a concrete pavement over the first 72 hours, when cracking potential is often highest.

In an effort to continually improve software models like HIPERPAV, we collaborated with the Cold Neutron Research Facility at the National Institute of Standards and Technology to apply their neutron-scattering technique to measure nondestructively the portland cement hydration process. This method provided a much more detailed picture of the complicated set of reactions involved in the setting and hardening of concrete. The data obtained made it possible to develop an accurate mathematical model of the reaction.

Expediting construction and repairs. Innovative construction contracting is another means of ensuring that highways are as available as possible to the public. With disincentives to contractors such as daily charges per lane mile when construction or maintenance makes the roadway unavailable to the motoring public, contractors have a financial interest in completing projects in a timely fashion. Another practice that fosters contractor efficiency is cost-plus-time bidding, in which the amount of time a project will take is assigned a dollar value and considered in addition to the bid cost. Through the implementation of warranty provisions, contractors are also being held more accountable for the work they perform. Just think of the possibilities if construction contractors have to guarantee their work against defects for a period of 5, 10, or even 20 years.

Snow plowing, city style. Although side-discharging snow plows work well on highways that have room for a pile of snow on the side of the road, this approach to snow removal can wreak havoc in a city. By moving snow from the roadway onto parked vehicles, sidewalks or driveways, motorists are inconvenienced, pedestrians are often splattered with the icy stuff, and business delivery entrances are routinely blocked. To improve snow removal in areas where the side of the road is an inappropriate area for snow dumping, rear-discharge, snow-blowing rotary plows are being used. The idea is simple—a snow plow removes the snow from the roadway and discharges it out the back of the plow, where it is deposited into a mobile

Pedestrians will benefit from alternate snow removal technologies.

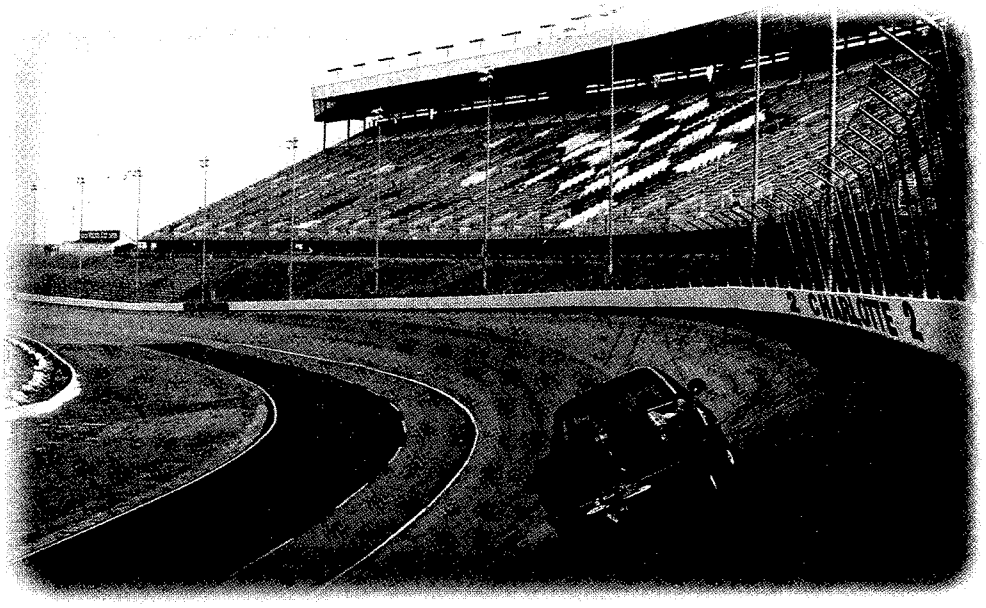
dumpster. Instead of being left at the side of the road for urban residents and businesses to clean up, the collected snow is then dumped elsewhere.

Keeping roads open under adverse conditions. New automated systems for minimizing avalanche hazards are in operation, primarily in the western States where an avalanche, or just the threat of an avalanche, can make closing a segment of highway a necessity.

Scanning highway bridge decks and pavements for damage. Although half the bridges in this country are covered with asphalt, no noninvasive method for evaluating the condition of concrete bridge decks covered with asphalt has been available—until now. We have developed a new high-speed radar imaging system for bridge deck inspection. The system, which uses an array of 64 specially designed radar antennae to scan a bridge deck at high speed, underwent full-scale field testing on two highway bridges in California this year with excellent results. This new tool stores the data from a high-speed scan and then produces two- and three-dimensional images of the interior of the concrete bridge deck. The completed scan reveals whether there is any interior damage to the concrete and reinforcing bars. This new inspection method is receiving high praise for being quicker, less disruptive to traffic, and more accurate than traditional, invasive methods.

Related technology enables ROSANv—the Road Surface Analyzer, vehicle mounted—to collect information used in analyzing textures and features of pavement surfaces while moving down a highway at 90 km/h. The information collected helps establish performance-related specifications to be used in pavement management systems. This method provides an alternative to the current, manually performed tests that require disruption to traffic flow because of lane closures. ROSANv also holds promise for use on airport runways where material from airplane tires, embedded in the runway surface during landing, must be removed from the pavement. Here, a ROSANv-equipped vehicle can scan the entire runway in a matter of minutes, avoiding the need to close a runway.

ROSANv collects pavement data at speeds of 90km/h.



As more and more researchers are using the Internet, there is a concerted effort to make our research, technology, and information available via the World Wide Web. Dissemination through the Internet provides FHWA research reports, summaries, program descriptions, and a wealth of other information to our American and international partners, "customers," and general public. Electronic publishing is growing at an astounding rate because it is faster and less expensive and more readily available to a broader audience than traditional printing.

The U.S. Department of Transportation's (DOT) home page *(http://www.dot.gov)* has links to FHWA, the National Transportation Library, the Bureau of Transportation Statistics, National Highway Traffic Safety Administration, Federal Transit Administration, Transportation Administrative Service Center, St. Lawrence Seaway Development Corporation, and the United States Coast Guard, among others. Stop by and hear or read a welcome message from DOT Secretary Rodney Slater, find a contact, or research the latest news and information affecting DOT. If you plan on doing business with DOT, check out the reference page on that topic!

The **FHWA** site *(http://www.fhwa.dot.gov)* walks you through FHWA's organizational structure and provides links to areas such as What's New, Program Areas, Publications and Statistics, Conferences and Training, Procurements, Legislation and Regulations, FHWA By Day, Field Offices, and ISTEA Reauthorization. If you select the Organization option, you will be taken to a "click-able" chart of the FHWA hierarchy. The links here will either take you to a more in-depth look at the particular office you have chosen or to a related web site. For example, if you click on the box for the Associate Administrator for Safety and System Applications, you will find links to the Office of Technology Applications (OTA), the National Highway Institute (NHI), and the Office for Highway Safety (OHS), each of which has its own web site.

Knowledge is power– but only if you can access it.

OTA's Highway Technet *(http://www.ota.fhwa.dot.gov)* contains a great deal of useful information. From demonstrations of the latest highway technology application, to a coloring book for kids, this site covers it all. The serious user will also be impressed by the OTA index of ongoing projects. Another site to cruise through is the **NHI** site *(http://www.nhi.dot.gov)*. NHI develops and administers transportation-related training and education programs that assist Federal, State, and local transportation agencies, as well as private transport providers and firms. NHI offers nearly 500 classes per year, and now conveniently offers a class list on its web site. Also available are a contact list of local FHWA coordinators and a listing of the fellowships and grants that NHI administers.

For those whose area of interest is **Intelligent Transportation Systems (ITS)**, stop by the ITS web site *(http://www.its.dot.gov)*. This site is still growing, but it promises to encompass a great deal of information from DOT on intelligent transportation. Since other excellent ITS resources already exist online, this site is meant to make information about the Federal (USDOT) involvement in the ITS program available and to direct the user to other valuable sources of information. Consisting of reports, databases, and related links, this is a good jump-off point to start an ITS research project.

Another FHWA site is the **Office of Motor Carriers (OMC)** web site *(http://www.fhwa.dot.gov/omc/omchome.html)*. Hazmat regulations, phone numbers for OMC division offices, downloadable OMC forms, information on Federal Motor Carrier Safety Regulations, and the Safety and Fitness Electronic Records System (SAFER) are just a few of the offerings currently posted on the OMC site.

A must-visit site for researchers is the **Turner-Fairbank Highway Research Center (TFHRC)** site *(http://www.tfhrc.gov)*. The TFHRC site is expanding weekly to promote FHWA research and development. With its expanding technical information base and the electronic versions of ***Public Roads*** and the ***Transporter***, the TFHRC site hosts almost 7,000 files of transportation-related information. Other items of interest include a researcher's directory, advanced research (artificial intelligence), human factors research, and hot ITS news!

In addition to these major sites, there are many divisional, regional, and program-specific FHWA sites.

STRATEGIC GOAL 2:

productivity

The efficiency of American business is directly linked to the efficiency of our National Highway System. As the saying goes, time is money—money spent waiting for inventory to be delivered, repairs to be made, customers to receive their merchandise, freight to move cross-country or cross-county, and employees to get to work. So the equation is simple, improve the efficiency of our Nation's transportation system, and we increase the potential of American business.

FHWA released new software to streamline the collection of roadside inspection information.

This means keeping bridges and highways open under all kinds of conditions, using materials that require less maintenance and last longer, minimizing bridge closures due to scour, expediting construction, and eliminating the delays now common when moving goods between ships, trains, and trucks or when trucks are stopped for inspection at weigh stations. Ongoing research and development under the Intelligent Vehicle Initiative (IVI) holds the key to many future advances that will enhance our productivity.

But as we increase potential for productivity, we also have to look at the human part of the equation. For example, in FY 1997, we released a study on commercial motor vehicle driver fatigue; we forged a partnership with industry to educate commercial drivers about fatigue; and we began developing the technology that will warn drivers when their level of alertness dips below an acceptable threshold. So, while we are working to increase productivity, we are doing so only in ways that will not compromise safety.

Bridge work—today only. In 1997, a fiberglass composite bridge—made from fiberglass, plastic, and resins—was installed in 1 day at a site in Russell County, KS. The new, lightweight material is strong enough to hold a vehicle weighing almost 500,000 kg but light enough to be hauled to the site for assembly in only one truck. Weighing one-third less than a conventional concrete and steel bridge deck, the 6.8-m-long, 8.2-m-wide bridge deck was glued together at the site and then covered with a driving surface made of polymer concrete. The composite bridge deck is light enough to offer the advantage of increased loading of existing beams and substructures, resistant to deicing and other chemical preparations, and fast to assemble.

Bridge surface freezes before roadway—until now. Nine demonstration projects located in Nebraska, Oregon, Texas, Virginia, and West Virginia are evaluating different methods of heating bridge decks to keep them from freezing. While the technologies differ from site to site, all monitor the road surface, heat it when climatic conditions are right for creating ice, then drain the runoff from the surface. Each site will be studied to determine how well the heated bridge decks perform, the cost of operating and maintaining each of the demonstration systems, increases or decreases in traffic volume, and crash statistics.

In a similar effort in Minnesota, bridge conditions and surface temperatures are monitored by a sensor system and a video camera. The bridge has an automated system that sprays liquid deicing chemicals on the bridge deck when needed. Similar projects deploy solid deicing chemicals from automatic dispensers for the same purpose.

Providing information on new materials and processes. The Superpave™ System, developed through the Strategic Highway Research Program, allows pavement designers to tailor asphalt mixes to specific traffic loads and climates. The Superpave™ system gives us more durable pavements that last longer and require less maintenance—qualities that translate into fewer work zones that slow traffic. To promote the use of this technology, our mobile laboratories, in FY 1997, assisted more than 15 of the Department of Transportation's design-and-build Superpave™ mixes. Workshops for more than 1,000 engineers were given on Superpave™ binder and mix design, and the five regional Superpave Centers were set up and organized into a cohesive training and research organization. Training courses to be delivered through the Superpave Centers were developed for the National Highway Institute. Cooperative agreements were established with the National Center for Asphalt Technology, the Asphalt Institute, and the National Asphalt Pavement Association to advance Superpave™ technology. In all, our support efforts will help 48 States build Superpave™ projects this year.

In a similar information transfer effort, we assisted 16 States in hosting high-performance concrete (HPC) structure showcases. These States are adopting HPC for concrete structure design and construction. Among the showcases that have occurred so far, 2½- to 3-day showcase workshops were held in Nebraska, Virginia, Washington, and New

The New Hampshire High-Performance Concrete Showcase drew over 200 attendees from government, academia, and industry.

Hampshire, with 200 to 230 attendees each; 1- to 1½-day mini-showcases were held in Arkansas, New Mexico, Oklahoma, Louisiana, Georgia, and Tennessee, with 40 to 150 attendees each. In addition, FHWA cosponsored an International Symposium on High-Performance Concrete for Bridges with the Precast/Prestressed Concrete Institute (PCI) in October 1997 in New Orleans.

Resisting the ravages of nature. More bridges fail each year as a result of scour than from any other cause. In FY 1997, we developed a hydraulic engineering circular (HEC) on scour and stream instability countermeasures to meet an urgent need to provide bridge owners with as much information as possible to safeguard the traveling public, especially on bridges that have been evaluated as scour-critical. HEC describes eight different measures that can be taken to prevent scour damage and channel instability and provides recommendations for monitoring structures. Designed to provide practical, down-to-earth approaches to practicing engineers and highway managers, this publication demonstrates one of our most cost-effective ways of deploying technology to all those who need it.

We also have developed a state-of-the-art advanced bridge instrumentation van for use in the load rating and performance monitoring of bridges. This mobile laboratory uses several innovative technologies we developed through our nondestructive evaluation program, including a laser system for making remote, noncontact deflection measurements of bridges and other structures; two wireless data acquisition systems that allow for the instrumentation of bridges without the cost and inconvenience of running wires from instruments to a centralized data acquisition system; a series of specialized transducers; and acoustic strain sensors that allow for rapid, real-time sensing of load conditions on a bridge. Like ROSANv, this mobile lab offers significant potential savings and the convenience of monitoring equipment that can move at the speed of traffic.

Enhancing Superpave™ technology. Superpave™ techniques create pavements that last longer and require limited maintenance; that translates into greater productivity because of fewer lane closures and slowdowns. As Superpave™ continues to evolve, we are developing a fundamental pavement-performance model that integrates mix design and that structural design and can be used in performance-related specifications. To ensure successful implementation of the improved mix design process, we also are developing a fundamental strength test for volumetric mix design.

Developing chemically modified crumb rubber asphalts. Many asphalts in use today are not suitable for the climate extremes in many locations in the United States. However, they may be chemically or polymer-modified and have their stiffness properties improved to make them suitable. FHWA chemistry laboratories recently discovered a process to obtain chemically modified crumb rubber asphalts by preparing chemically modified crumb rubber and reacting it with asphalts. This patent-pending process provides a means to modify both regular and polymer-modified asphalts with chemically modified waste crumb rubber from scrap tires. This can then be used to produce pavement binders that are homogeneous and show little phase separation in use, with improved high- and low-temperature asphalt

performance, and at costs that are competitive with other modified asphalt binders. On the basis of laboratory results, the modified crumb rubber asphalts are expected to be effective for most pavements in areas that experience wide temperature variations. We are currently working with several refineries and crumb rubber producers to produce asphalt products, and we plan to conduct pavement demonstration projects using the new modified crumb rubber asphalt materials.

Employing new tools. Conventional deflection measurements for bridge structures are time-consuming to prepare and often require access under the bridge structure—that means interrupting traffic flow. With our new laser-based precision range-measuring device, the Coherent Laser Radar (CLR) System, we can accurately measure distances from the device to an object, such as a steel girder or a concrete wall, without performing any special surface preparation. Better still, these measurements can be made from a location that does not require altering traffic. Initial field testing has shown that set-up time for this device is minimal and a greater number of measurement locations can be obtained with the laser system than by traditional means.

Increasing productivity through better management. In addition to more than 550,000 bridges in the United States, there are almost 6.3 million km of streets, roads, and highways. This infrastructure represents a considerable financial investment estimated at more than $1 trillion. To better manage these assets, FHWA and the American Association of State Highway and Transportation Officials (AASHTO) are continuing to promote and practice asset management, a systematic practice of maintaining, upgrading, and operating physical assets cost-effectively. We developed a technical bulletin on life-cycle-cost analysis, are providing training in the application of fundamental life-cycle-cost analysis and risk analysis software, and are applying this software in the development of real-world case studies. And, in cooperation with AASHTO, we jointly sponsored two national workshops on asset management.

Fostering interagency cooperation. In February, FHWA and the Corps of Engineers signed an agreement to facilitate timely decisions on permit applications from State highway agencies and other bridge owners for work associated with measures to protect scour-critical bridges.

Staying relevant. We are performing a strategic reassessment of the scope, purpose, and objectives of the Highway Performance Monitoring System (HPMS). In our review of this data collection and analysis system, we are gathering input from our customers, partners, stakeholders, and other interests affected by HPMS, assessing a number of critical issues related to the current HPMS and providing guideposts for its future form and direction.

To better manage an infrastructure investment of more than $1 trillion, FHWA and AASHTO are promoting and practicing systematic asset management.

Computerizing analysis for bridge repairs, restoration, and maintenance. Kuwait and Hungary have joined the 40 States in the United States that are using Pontis software to manage their bridge inventory. In July, Pontis 3.2 was released to deliver added user convenience and more user control. Users can now simulate needs for one, several, or all elements in a particular programming scenario.

Promoting efficient financing and equitable highway user fees. All new construction and highway improvements have one thing in common—they require funding. In FY 1997, FHWA conducted research on numerous innovative finance mechanisms. We surveyed organizational structures and intragovernmental relationships; assessed market demand; analyzed different forms of financial assistance, including loans and credit enhancement; capitalized banks through grants and debt; monitored credit exposure; established accounting structures and investment policies; and assisted transit projects. A significant aspect of our innovative finance research and technology transfer involved State Infrastructure Banks (SIB's). We created an SIB Primer that explains the potential role of SIB's in Federal transportation finance policy and explores the financing mechanisms that can be used by SIB's in assisting individual projects. We also designed a sam-

PHOTO COURTESY OF THE NEW YORK THRUWAY AUTHORITY

Scrutinizing highway users fees; are the existing ones appropriate?

ple cooperative agreement, sample enabling legislation, and an SIB workshop to provide technical assistance to Federal and State officials creating or operating SIB's. Finally, we provided an initial evaluation of the SIB pilot program to Congress in our SIB Report.

In FY 1997, we also completed a multiyear cost allocation study that examined highway-related costs attributable to different vehicle classes as a basis for evaluating a variety of transportation policy issues including: the equity of highway user fees levied on different vehicle classes at all levels of government; the total costs associated with highway use by different vehicles, including infrastructure costs borne by public agencies, safety and congestion costs largely borne by highway users, and environmental and other costs borne by both users and nonusers; and changes in highway costs that might be expected under options being evaluated in the Department's Comprehensive Truck Size and Weight Study. The 1997 Federal Highway Cost Allocation Study provided Congress, State and local transportation agencies, other government agencies, industry groups, and academia the first comprehensive look at the allocation and equity of the Federal highway user fee structure since 1982. This study involved wide-ranging research into pavement deterioration modeling; bridge analysis; vehicle miles of travel and operating weight distributions for different vehicle classes; passenger car equivalencies; expenditures by Federal, State, and local agencies for highway-related improvements; and marginal costs of highway use by different vehicles.

New facilities help build new ideas.

In 1997, new construction began on a Nondestructive Evaluation (NDE) Validation Center located at the Turner-Fairbank Highway Research Center. The NDE Center will provide a national resource for the development and application of NDE technologies. It will validate the performance of NDE methods and accelerate development and implementation in this critical area. The center consists of a laboratory for performing validation testing, a library of bridge components containing defects, and full-scale test bridges as field test sites.

STRATEGIC GOAL 3:

safety

It is a fundamental and obvious relationship: Reducing the number and severity of highway crashes reduces the human suffering and economic impact of traffic crashes. Enhancing safety is the third strategic goal of FHWA. Technology is playing a role in helping to create safer highways for the future. Preliminary estimates by the National Highway Traffic Safety Administration (NHTSA) indicate that rear-end, lane-change and roadway-departure crash countermeasure systems have the potential, collectively, to reduce motor vehicle crashes by more than 1 million police-reported crashes annually if these technologies are fully deployed in the vehicle fleet. Working in cooperation with other agencies like NHTSA and the private sector, FHWA is developing new analytical tools that provide capabilities to design and build better and safer highways. We are forming new partnerships and creating programs, devices, and materials that focus on keeping vehicles on the road. When vehicles do leave the roadway, the improved roadside hardware we are developing, such as composite guardrails, will reduce the severity of crashes.

Crashtesting composite end terminals at the Turner-Fairbank Highway Research Center.

Intelligent technologies include radar unit that detects obstacles and maintains headway distance.

Intelligent partnering to produce intelligent vehicles. Earlier this year FHWA, NHTSA, and the Federal Transit Administration (FTA) formed a partnership to create a major research program known as the Intelligent Vehicle Initiative (IVI). This multiyear program will accelerate the development and deployment of integrated in-vehicle systems—such as route guidance systems, collision-avoidance and alert systems designed to alert the driver whenever another object is in the driver's blindspot or when the gap between the driver's vehicle and another vehicle is closing to a dangerous margin—and automation systems that will temporarily take over driving during emergencies or allow autopiloting for prolonged durations. IVI will integrate the driver/vehicle on the roadway through a total systems approach. Roadway sensors, vehicle sensors, actuators, and the driver will be integrated and used to reduce the number of driver-error crashes on our highway system, resulting in 70 percent to 90 percent fewer driver errors. Estimates project that we could eliminate one in six crashes by using blindspot technology and intelligent cruise control that maintains a constant interval between vehicles instead of a constant speed. This initiative will be conducted in cooperation with industry, the States, and academia to develop capabilities for fully cooperative vehicle/roadway/driver systems.

Saving lives with intelligent vehicles. The Automated Highway System program is one of the building blocks for the Intelligent Vehicle Initiative. In addition to the increased mobility offered by AHS, this system has very important safety capabilities. The 3,500 participants in Demo '97 in San Diego from August 7-10 experienced safety systems ranging from simple warnings to the driver that the vehicle was straying from its lane to automated systems that fully controlled the speed as well as the lateral and longitudinal position of the vehicle without the assistance of the driver. About 90 percent of all crashes are caused by driver error, and Demo '97 established the technical feasibility of automated vehicle control, crash-avoidance, and vehicle-to-vehicle-communications systems that have a great potential to radically reduce the opportunity for driver error and, subsequently, the number of crashes.

Designing highways to be safe. We continue to make significant progress in the development of the Interactive Highway Safety Design Model (IHSDM), a suite of computer programs that will give highway planners and designers a tool to evaluate safety implications of design decisions from the planning stage through final design. This computer-aided design package will simulate driver responses to highway designs, adding the human element to the design equation. A modular approach is being used to develop the model, and prototypes of modules for crash analysis, design consistency, and policy development are already available. To get this vital tool into the hands of roadway planners and designers, we entered into a cooperative research and development agreement with one of the leading highway design software companies in the country. This and future agreements will ensure that IHSDM is compatible with and distributed with other highway design software in use by State departments of transportation and their consultants.

UV headlights and fluorescent markings are a bright idea. The farther away an object is before a driver sees it, the more time the driver has to respond to it.

Increasing driver response time often equals increasing highway safety. Fluorescent pavement markings installed on a section of the Clara Barton Parkway in Maryland were used in a demonstration project to test the visibility of the markings with and without ultraviolet (UV) headlights. This demo proved that the new fluorescent markings and UV headlights installed on the test vehicle, a 1993 Volvo 960, could increase lane-line visibility by about 30 m when compared with standard low-beam headlights.

Improving roadway hardware through simulated crashes. In cooperation with The George Washington University, we have developed new capabilities to simulate crash tests through computer modeling. Using the university's super-computing center, in conjunction with the National Crash Analysis Center, models can predict the behavior of vehicle crashes. Used in concert with limited full-scale crash testing, these new capabilities will reduce the costs of developing innovative approaches to roadside hardware such as composite guardrails and better performing end treatments. Whether using simulated or full-scale crash testing, the objective is clear—provide roadway hardware that will stop vehicles involved in crashes in the most occupant-friendly manner possible.

Applying new technologies throughout the Nation. The National Model effort, established this year, is applying advanced data collection and management technology to improve highway safety. Advanced Law Enforcement Response Technology (ALERT) vehicles, expert systems, global positioning systems (GPS), and advanced communications systems are some of the technologies being implemented. The National Model aims to bridge the gap between the state of the practice—pen and paper, tape measure, retrofitted vehicles, and maps—with the state of the art—pen-based computers, bar code readers, GPS receivers, expert systems, laser measurement, and digital cameras. The goal is to shorten the time it takes to implement new technology in the field and to raise awareness among the States about the availability and applications of new technologies.

Increasing the odds. Approximately one of every six highway fatalities in the United States is a bicyclist or pedestrian. In FY 1997, we developed and released three products to aid engineers and planners in better accommodating the needs of pedestrians and bicyclists by improving safety and increasing mobility. The Pedestrian and Bicycle Crash-Analysis Tool is a software program that allows the user to classify bicycle or pedestrian crashes and suggests specific countermeasures that can be implemented to reduce the frequency of such crashes. The Bicycle Compatibility Index is intended to be used by bicycle coordinators, transportation engineers, and planners to evaluate an existing roadway's "bike friendliness" and determine what improvements may be required to provide an increased level of bike service. The geographical information system for developing safe routes to school identifies the quickest and safest walking route to school for elementary children and determines the need for crossing guards, crosswalk markings, and signs.

Rethinking roads for an aging population. Continued mobility for older drivers is a significant concern, not only for the individual, but also for the transportation official who must recognize and account for changes in skills, capabilities, and habits of older drivers. In 1997, FHWA developed and released the *Older Driver Handbook* to assist designers in considering the needs of the senior driver. A product of a team effort with NHTSA, the handbook will assist designers in intersection design, roadway geometry (including passing zones), and special work zone considerations—all with the older driver in mind. We are working to encourage widespread use of the handbook by planners and engineers in the field.

Guiding industry to promote worker safety. FHWA is working with the National Institute for Occupational Safety and Health and the asphalt industry to control exposures to asphalt fumes given off during paving operations performed by highway-class asphalt pavers. In January 1997, guidelines for highway-class, hot-mix asphalt pavers directed paver manufacturers to

About 90 percent of all crashes are caused by driver error, and these 67 established that automated vehicle control, crash-avoidance, and vehicle-to-vehicle communications systems have a great potential to radically reduce the number of crashes.

Two recent FHWA-sponsored scan tours include Asian Bridge Structures (above) and Roadway Safety Audits.

develop and install exhaust ventilation systems with a minimum controlled indoor capture efficiency of 80 percent. Although the compliance with the guidelines was voluntary, the response from industry was overwhelmingly positive; representatives from the paver manufacturers, Department of Labor, National Asphalt Pavement Association, FHWA, and the labor unions have all signed nonregulatory agreements in accordance with the guidelines.

Increasing visibility of highway markings. When is it easiest to see an object: (a) when the light that illuminates the object is reflected back to its source or (b) when some light that illuminates the object returns to its source and the rest is dispersed in other directions? The answer is (a), and this principle, called retroreflectivity, plays an important role on our Nation's highways. Three different metering devices are being used in an ongoing field survey to measure the retroreflectivity of different types of pavement markings used throughout the States. The retroreflectivity is measured when the markings are first applied and after they have aged. Using this technique, we are developing recommended minimum retroreflectivity values as well as durability measurements for a variety of pavement marking materials at various locations throughout the United States. Through the analysis of these study data, our team also is investigating the economic implications of setting particular threshold values for replacement of pavement markings, installation and maintenance costs, traffic disruption, and compiling crash data that are correlated to the type of pavement markings.

Reducing or upgrading rail crossings. As the United States develops high-speed rail corridors, it is essential that we improve our highway-rail crossings. In September 1997, we visited Denmark, The Netherlands, Germany, Italy, and Spain to study warning systems and barriers that are currently in use for high-speed European rail operations. The report containing our findings from this scanning tour will be available in early FY 1998. We also are working with the Federal Railroad Administration (FRA) to improve safety and decrease rail-crossing fatalities by reducing the number of rail crossings in the country.

Improving traffic control. In cooperation with the Maryland State Highway Administration, we developed and deployed a portable, condition-responsive work zone traffic control system. The system was used on an approach to Ocean City, MD, to alert high-speed traffic of stopped or very slow moving traffic ahead. This variable message sign provided real-time information, posting a variable recommended speed that changed according to traffic conditions ahead. The system collects data through traffic sensors and a network of data collection devices called roadside remote stations, and it analyzes the data to predict delay and to detect hazardously high differential speeds between upstream and downstream traffic. To enhance the system's credibility and improve driver compliance with the messages, the system updates and time-stamps variable message sign information as needed.

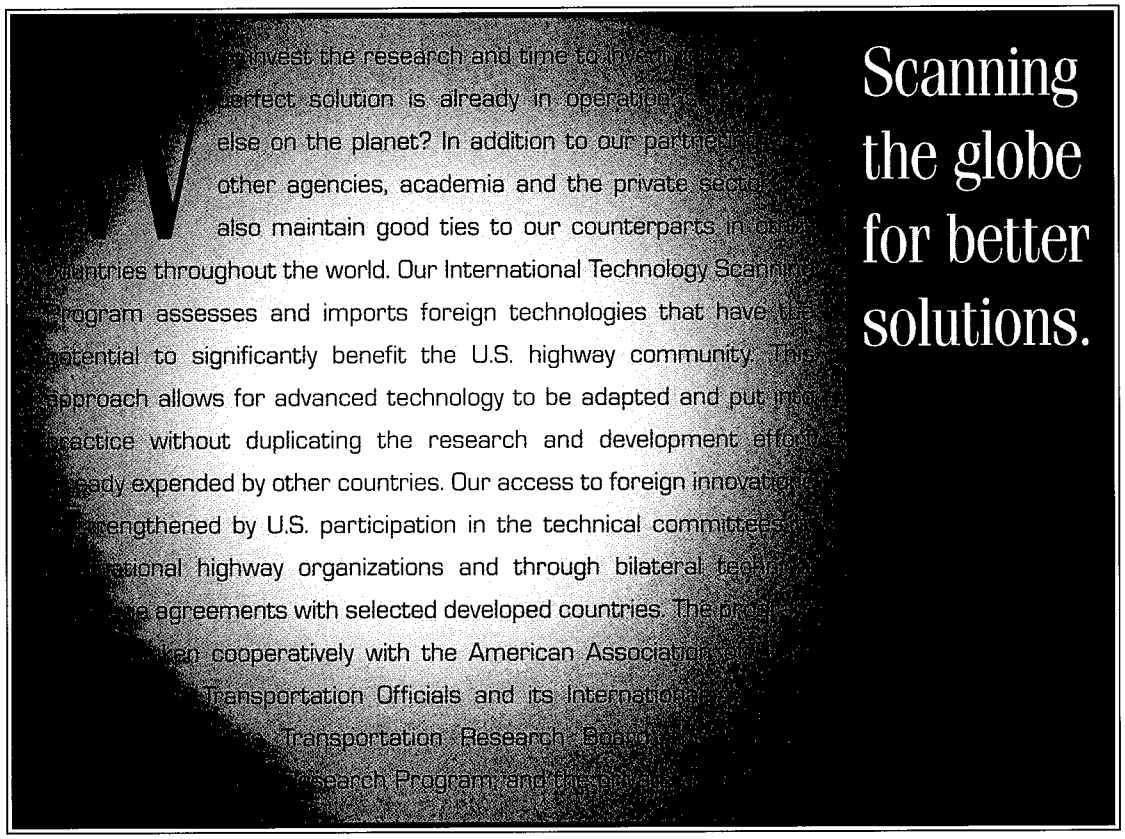
Similar technology is also being used on three ramps of the Washington, DC, Capital Beltway to warn trucks of excessive speed and the potential to rollover. The system measures the truck speed, weight-in-motion, and height and then determines vehicle type. If the system records a speed that exceeds the safe speed for that particular ramp, it signals a fiber-optic sign to display "trucks

reduce speed." Researchers found that truck drivers did slow their vehicles in response to the warning signs. In a similar application, this same system is being used to warn vehicles too tall for an upcoming overpass that they just won't fit.

Driver fatigue and alertness. The landmark Driver Fatigue and Alertness Study, a 7-year study on commercial motor vehicle driver fatigue, in which 80 long-haul drivers were observed for more than 4,000 driver hours, was released in January 1997. The major findings indicated that time of day has more impact on alertness than cumulative time on duty, drivers were not good at assessing their own levels of alertness, and significant individual differences were noted among drivers in levels of alertness and driving performance.

Commercial driver outreach. To educate commercial drivers and others in the industry about the dangers of fatigue, an outreach project was initiated in partnership with the private sector. As part of the project, print and audiovisual materials were developed and distributed nationwide. A major goal was to produce an instructional program about how to recognize fatigue, the importance of adequate rest, effective countermeasures, and making healthy work and lifestyle choices. In addition, we cosponsored two fatigue-related conferences during the past year: the "Technical Conference on Enhancing CMV Driver Vigilance" in December 1996 and the "Managing Fatigue in Transportation Conference" in April 1997.

Smart cards in commercial vehicle operations. A 15-month study, which was completed in December 1996, looked at using "smart cards" in such areas as issuing commercial driver's licenses, vehicle registrations, electronic purses, and automating the inspection process. The report concluded that smart cards contribute to improved highway safety and increased productivity.



STRATEGIC GOAL 4:

human & natural environment

In 1997, we found ways to be gentler on our natural environment by doing more with fewer natural materials and by reusing materials that previously did no more than clog the waste stream. We have developed and implemented programs to promote biking and walking as alternative forms of transportation, and we are enhancing the safety of bikers and pedestrians by using technology to improve the visibility of pedestrian crossings and of pedestrians themselves.

Finding ways to minimize environmental impacts and conserve our resources.

What about reducing pollution? Before we can begin to eliminate air, water, or noise pollution, we need the tools to accurately identify and quantify it. To attain that goal we placed special emphasis on updating our methods and models for measuring vehicle emissions, highway runoff, and highway-related noise pollution. Our air quality research is providing a more sophisticated and reliable means to determine the degree to which today's vehicles cause pollution and to identify which pollutants are being emitted into our air. Since passage of the Clean Air Act Amendment of 1990 and the Intermodal Surface Transportation Efficiency Act of 1991, the Research and Technology Program has increasingly examined the relationship between vehicle use and violations of the National Ambient Air Quality Standards. Consequently, we place considerable importance on improving our means of estimating emissions from highway sources. To achieve this goal, we are updating and refining the data, methodologies, and models used to estimate vehicle emissions.

Similarly, the effects of highway runoff on wetlands is also an area of concern and continued research. But here, too, we must update our inventory of the pollutants that affect our wetlands today and our methods of quantifying those pollutants, and then we can see if highway runoff is a cause of pollution to wetlands. Studies to date indicate that highway runoff is not a significant source of wetland pollution. In the area of noise pollution, we have developed a state-of-the-art model to measure highway-related noise that will aid us in minimizing this type of pollution.

New materials use less of our natural resources. The stronger and more durable a material is, the less of it we need to use and the longer it will last. This type of thinking guided the development of a new grade of high-performance steel, dubbed HPS-70W. HPS-70W progressed from research to practice in less than 5 years as the result of a program sponsored by FHWA in cooperation with the U.S. Navy and the American Iron and Steel Institute and with the collaboration of AASHTO, academia, and the private sector. This steel was designed to improve both the cost-effectiveness and safety of bridges through its higher strength, excellent weldability, and enhanced ability to tolerate defects and damage. The first two HPS-70W bridges were constructed in 1997 in Tennessee and Nebraska. The Tennessee bridge used the high strength of HPS-70W to reduce weight and reduce the cost of steel fabrication by more than 16 percent compared with traditional steels. At least 12 additional HPS-70W bridges are scheduled for construction in 1998 throughout the United States with projected additional savings in materials and cost. The Civil Engineering Research Foundation recognized this collaborative effort as the most significant innovation in the construction industry for 1997.

Minimizing the impact of development on water quality. Our crowded, highly developed urban areas require new thinking when it comes to the management of stormwater runoff and water quality. Best management practices (BMP's) have been used to reduce peak flows, runoff volumes, and the magnitude/concentration of pollutants in runoff. In highly urbanized or impervious areas, space limitations introduce new requirements such as high efficiencies, limited or infrequent maintenance, accessibility, and safety. To aid planners and designers, we have compiled a report that defines the available knowledge on ultraurban BMP's; examines the constraints, design criteria, and potential benefits; and suggests a method to target monitoring programs based on the needs of an individual area. The report's accompanying searchable database can be used as a guidance tool to help planners and designers focus on projects that possess the greatest similarity to their own local conditions.

Eliminating material from the waste stream. Highway engineers and waste producers now have a new guidance manual to help them use waste and byproduct materials appropriately and effectively in pavement construction. Guidelines for Use of Waste and Byproduct Materials in Pavement Construction provides information on 19 waste and byproduct materials, and it

Alkali silica reaction test site near Durham, NH.

addresses the use of these materials in seven pavement construction applications. The manual describes the origin, sources, and properties of each material. For each appropriate material-application combination, this manual discusses past performance, engineering properties, processing requirements, design and construction guidelines, and unresolved issues. The manual also offers general guidance on environmental and cost issues and on issues involved in determining the suitability of an untried material.

In a similar effort, FHWA and a consortium led by the University of New Hampshire are conducting research to expand waste usage in highway construction. Technical studies include work to solve alkali silica reaction problems that limit the use of recycled concrete aggregates in new portland cement concrete, development of performance-based specifications for cold in-place recycling of bituminous materials, development of a consensus-based framework for waste evaluation procedures, and the use of accelerated aging tests and evaluation products to predict the future behavior of highways made with recycled materials. To assist the engineering and environmental communities in implementing the study results, we will publish a variety of reports, including Internet-based guidance documents.

Keeping pace with emissions analysis. Analytical methods for both transportation and emission models were formulated more than 30 years ago and no longer fully reflect the current understanding of either travel or important emission considerations. This ongoing project will develop an integrated model, as well as needed data-collection and analytical methods to create an improved emission inventory methodology for highway vehicles. This project is already generating important new understandings and possible new strategies for reducing future emissions from highway sources.

In a similar effort, FHWA has documented the structure of the current Mobile 5a version of the emissions model. For 25 years, transportation and air quality officials have used outputs from their respective modeling processes to estimate emissions from highway vehicles. Unfortunately, the development of the individual models was not closely coordinated. This has led to considerable confusion when the models are linked and causes unreliable results that are based on incompatible assumptions. Our mobile model evaluation was reviewed by the Environmental Protection Agency, and, since its release, it has become the standard for describing the emission model structure.

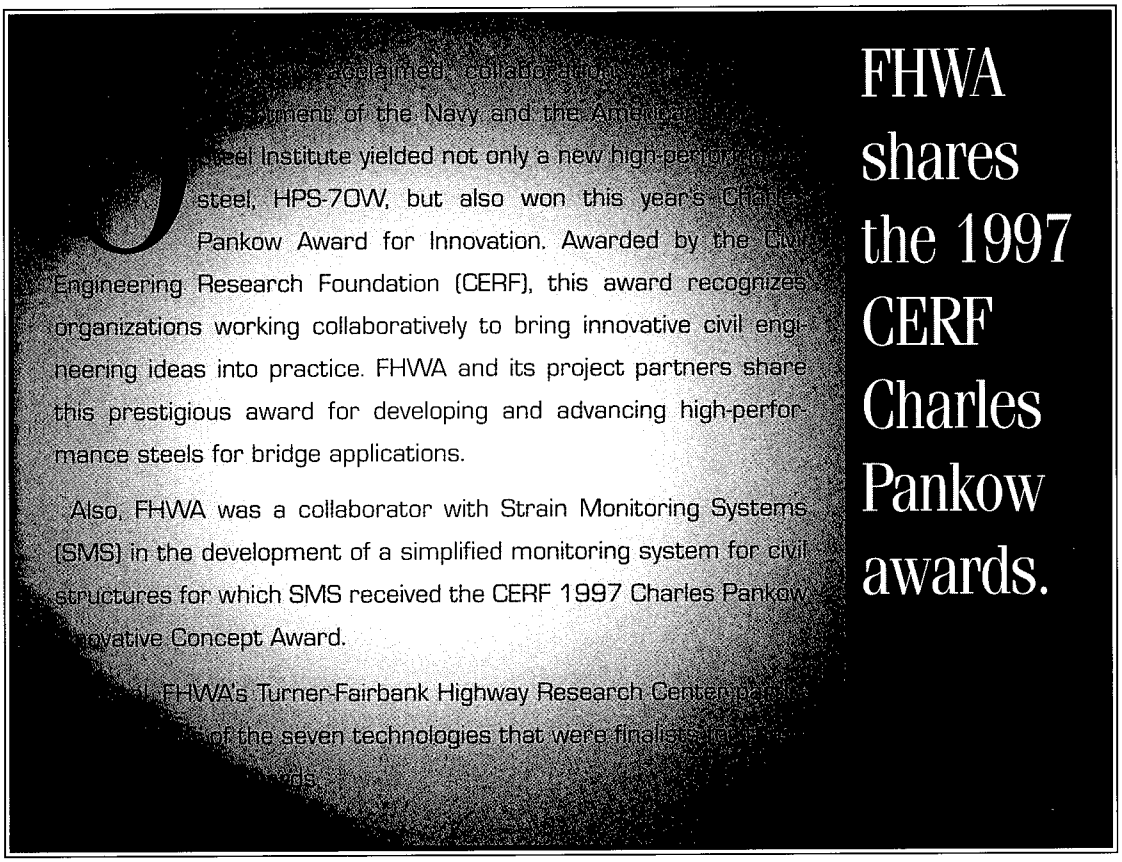
Lessening pavement noise. On certain concrete pavement surfaces, vehicle tires produce a whine that can be annoying to motorists, as well as to nearby residents. The problem is that although portland cement concrete (PCC) pavement produces a surface that tires can grip easily and reduces the likelihood of skidding, tires traveling over this surface tend to make a lot of noise. The challenge is in lessening the noise without losing the desirable qualities offered by a good, gripping surface.

Our research has shown that when the microtextures that are placed in cement before it has hardened are spaced evenly, more noise is generated by tires traveling over the pavement. When these microtextures are spaced unevenly, however, the harmony is broken and less noise is produced when tires travel over such a surface. For pavements longitudinally or transversely tined, we are investigating: durability of PCC compared with asphalt cement surfaces, associated ride on the various textures, econ-

omy of construction, specification of desired texture, and verification of texture quality. The goal is to provide improved guidelines for maintaining high-friction values that reduce the likelihood of skidding while minimizing the characteristic tire whine and sacrificing neither safety nor durability.

Measuring highway-related noise. With support from the Volpe National Transportation Systems Center Acoustics Facility, we have developed a new measurement manual that documents recommended procedures for the measurement of existing noise, vehicle noise emissions, noise reduction due to barriers, construction equipment noise, noise reduction due to buildings, and occupational noise exposure. This report also addresses improvements and changes in noise measurement technologies.

Promoting pedestrian programs. In 1997, we conducted train-the-trainer sessions in conjunction with half-day road shows that were designed to encourage communities to initiate and implement programs for safe walking. This supports the Department of Transportation initiative to promote walking as a mode of transportation and has received great interest from local agencies. Conducting train-the-trainer sessions with each road show empowers FHWA field offices and our partners in State agencies to perform additional sessions and to serve as a technical resource to communities as they implement programs. Keeping technology in pace with our training initiative, we are also developing pedestrian signs that present the international pedestrian symbol on a new fluorescent background and are easier for drivers to see. There's even research into special laundry additives that will add a fluorescer to clothing without damaging fabrics. The approach is simple: Increase pedestrian safety and awareness, and we will correspondently increase pedestrian traffic.



STRATEGIC GOAL 5:

national security

Our highways play a big role in the Nation's ability to respond to emergencies and natural disasters. How quickly and efficiently can first responders reach the scene of an incident? How fast can a hurricane evacuation be accomplished? How well do we respond to flooding conditions that place enough additional water pressure on bridge structures that closures may be necessary? It's all part of our role in ensuring public safety.

The Scour Research Team and MNDOT inspectors wade to a flooded bridge on Highway 23.

Protecting our law enforcement officers. The ALERT (Advanced Law Enforcement Response Technology) program has developed and showcased onboard vehicle integration technology that can control and sequence vehicle functions, communications, and digital information management. In 1997, we completed ALERT development and are currently performing testing and evaluation. The first application of ALERT technology is an advanced law enforcement vehicle that enables an officer to operate lights, siren, radar, video camera, and global positioning equipment independently or from a programmed sequence entered into the touch screen of an in-vehicle computer. An officer with an ALERT vehicle can enter crash or citation information electronically instead of "calling it in" and receive fingerprint identification information and mug shots over a radio frequency link. A major advantage is that our law enforcement officers will spend less time in harm's way while waiting to learn if a detained individual presents a risk. But should an officer require assistance, ALERT's global positioning equipment pinpoints the location of the ALERT vehicle. The ALERT system can be transferred from one vehicle to another and has been designed with a standard interface that makes it compatible with a host of peripheral systems, including radios; radar; global positioning and global information systems displays; bar code, mag stripe, and fingerprint scanners; digital cameras; infrared systems; and countless other devices. Other applications—such as for ITS, military field vehicles, or other public safety first responders, including fire or emergency medical services—are being investigated.

How safe is that bridge? Dealing with spring flooding and the ensuing increased strain on highway bridges is an annual event for the Scour Research Team. In April 1997, the team was dispatched to evaluate numerous bridges in Minnesota and North Dakota. As a result, two bridges in Minnesota—the U.S. Route 212 bridge spanning the Minnesota River and the bridge over Pome de Terre Creek in Swift County—were closed, and only 2 hours after the closure, the Route 212 bridge collapsed. Because of the quick and accurate efforts of the Scour Research Team in these and other areas of the country, motorists are better protected from potential bridge collapses and unnecessary closures.

Earthquake damage reduction. We issued a two-volume circular entitled "Geotechnical Earthquake Engineering for Highways." This design-guidance document provides information on how to apply principles of geotechnical earthquake engineering to the planning, design, and retrofit of highway facilities. Topics discussed include seismic hazard assessments, evaluation of design ground motions, seismic and site response analyses; evaluation of liquefaction potential and seismic settlements; seismic slope stability and deformation analyses; and seismic design of foundations and retaining structures. Design examples are also provided.

Smithsonian Institution honors ALERT project team.

This year's Computerworld Smithsonian Awards Program recognized the ALERT project team as innovators and outstanding users of information technology who have used this technology to benefit mankind. The groundbreaking work of the ALERT team will be included in the Smithsonian's permanent research collection, which strives to "capture a global revolution in progress; to document, preserve, protect and interpret for future generations work that is representative of a phenomenon that has already changed the world and is continuing to do so in ways that are redefining human enterprise."

CONCLUSION:

the road ahead

Fiscal year 1997 was an introspective year for the R&T Program. We examined the direction of our program and were increasingly selective in exactly where we focused our resources. With the myriad of new technologies and their applications, we concentrated on the ones that will reap the greatest rewards.

New lateral control technologies promise a big payoff in the future.

PHOTO COURTESY OF PATH PUBLICATIONS

Each Research and Technology Coordinating Group is developing a comprehensive "roadmap" for its area. The groups are examining in detail the answers to some fundamental questions that will drive the development of the RTCG's programs. These questions include: What specific goals within the RTCG's area must be achieved to enable FHWA to meet its strategic goals? What intermediate steps must be taken to reach the RTCG goals? What do we know about what works and what does not? Where are the gaps? How can we measure our progress? Each RTCG is contributing to the achievement of FHWA's strategic goals.

We are working to increase productivity and efficiency. We are placing emphasis on identifying and using materials of higher initial quality—such as high-performance concrete, high-performance steel, high-performance composites, aluminum, and the Superpave system—that offer increased durability and other advantages. Starting with better materials limits the need for repairs that pose an economic burden and limit highway capacity during repair operations. When, through our efforts today, the lifespan of future roads is 25 or perhaps even 50 years, instead of 10 to 20 years as most are now, and when the average bridge life is 75 to 100 years, instead of the current average of 42 years, the need for roadway repairs will decrease, as will construction and maintenance delays. This long-term strategy will dramatically increase the efficiency of our National Highway System.

Similarly, we are concentrating on saving lives and decreasing congestion through the use of intelligent transportation systems. Each year in the United States, more than 40,000 people are killed and 5 million people are injured in automobile crashes. Because human error is a leading factor in nine out of 10 crashes, ITS offers a great potential for improving safety through the concepts and technologies developed in conjunction with the Intelligent Vehicle Initiative, which promises to significantly reduce the element of human error. ITS can reduce congestion and increase mobility in several ways, but primarily, by being able to safely reduce the distance between vehicles, ITS can double the capacity of our roadways at today's legal speeds and make trips faster and trip times more reliable by preventing the backups due to stop-and-go traffic and the slowdowns due to crashes. The Intelligent Vehicle Initiative will help focus our research agenda on making our highways safer and more efficient.

ITS will also increase productivity, particularly for commercial users, and will reduce the need for new construction. ITS also offers many other economic, environmental, social and institutional, and technical benefits.

Regardless of the technologies used or policies defined, all of our goals are only attainable with a dedicated and well-educated staff. The leaders of FHWA are proud of the talented professionals who work in the R&T Program—both at FHWA headquarters and in the field where much vital work is being performed. We believe in professional capacity building because the individuals who are best at what they do are those who look to continually increase their own knowledge base. The journey toward continuous quality improvement is not only for organizations; it is for individuals as well.

The R&T Program's reputation for excellence and innovation is well-known throughout the global highway research community. Our reputation is reaffirmed when our programs win awards for innovation and when we hire staff members who come from respected positions within academia or the private sector. By benchmarking with other laboratories, we are putting our reputation, as well as our innovations, to the test. Another testament to our continued commitment to excellence is the outstanding support that our advanced research activities and our routine research and development activities have received during the review of legislative proposals for Congress' reauthorization of the funding for our work. We are gratified that our service to the Nation is recognized at the congressional level, and we are committed to continuing to earn the respect of the global community and the Nation by providing the type of innovations upon which we have built our reputation and the National Highway System.

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